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SOLUTION BY LOUIS WEISNER, Student, College of the City of New York.

From the given equations, we have

$$B_1\cdot B_2 = (c_1c_4 + c_1c_3 + c_2c_4 + c_2c_3)A_1\cdot A_4 + (c_1c_4 - c_1c_3 + c_2c_4 - c_2c_3)A_1\cdot A_2 + (c_1c_4 + c_1c_3 - c_2c_4 - c_2c_3)A_3\cdot A_4 + (c_1c_4 - c_1c_3 - c_2c_4 + c_2c_3)A_3\cdot A_2$$

$$B_3\cdot B_4 = (c_2c_3 + c_2c_4 + c_1c_3 + c_1c_4)A_2\cdot A_3 + (c_2c_3 - c_2c_4 + c_1c_3 - c_1c_4)A_2\cdot A_1 + (c_2c_3 + c_2c_4 - c_1c_3 - c_1c_4)A_4\cdot A_3 + (c_2c_3 - c_2c_4 - c_1c_3 + c_1c_4)A_4\cdot A_1.$$

Adding,

$$B_1\cdot B_2 + B_3\cdot B_4 = (2c_1c_4 + 2c_2c_3)A_1\cdot A_4 + (2c_1c_4 + 2c_2c_3)A_2\cdot A_3 = 2(c_1c_4 + c_2c_3)(A_1\cdot A_4 + A_2\cdot A_3).$$

By definition $M\cdot N = mn \cos MN$, where m and n are the lengths of M and N, respectively, and $\cos MN$ is the cosine of the angle between the vectors M and N.

Hence,

$$b_1b_2 \cos B_1B_2 + b_3b_4 \cos B_3B_4 = 2(c_1c_4 + c_2c_3)(a_1a_4 \cos A_1A_4 + a_2a_3 \cos A_2A_3).$$

Also solved by the PROPOSER.

2704 [May, 1918]. Proposed by WILLIAM HOOVER, Columbus, Ohio.

A particle moves from rest under gravity down the arc of a parabola with the axis vertical and concavity upward; express the time to the vertex in terms of an elliptic integral of the second kind.

SOLUTION BY THE PROPOSER.

Taking the y-axis along the axis of the curve, the equation of the parabola is

$$x^2 = 4ay. \tag{1}$$

In the usual notation, the equation of motion of the particle is

$$mv\frac{dv}{ds} = -mg\frac{dy}{ds}.$$

Multiplying by $2ds$ and integrating,

$$v^2 = -2gy + C. \tag{2}$$

When $v = \dot{s} = 0$, let $y = h$; then $C = 2gh$, and (2) is

$$\dot{s}^2 = 2g(h - y). \tag{3}$$

From (1),

$$\dot{s} = \sqrt{\frac{a + y}{y}}\,\dot{y}$$

and (3) becomes

$$dt = -\frac{1}{\sqrt{2g}}\sqrt{\frac{a + y}{y(h - y)}}\,dy. \tag{4}$$

Now change the variable by setting $y = h - hy$; then

$$dt = \frac{1}{\sqrt{2g}}\sqrt{\frac{(a + h) - hy}{y(1 - y)}}\,dy. \tag{5}$$

The upper and lower limits in (4) are $y = h$, $y = 0$, and so (5) gives

$$t = \frac{\sqrt{h}}{\sqrt{2g}}\int_0^1 \sqrt{\frac{\frac{a + h}{h} - y}{y - y^2}}\,dy = \sqrt{\frac{2(a + h)}{g}}\,E\left(\sqrt{\frac{h}{a + h}}\right).$$

Also solved by R. C. COLWELL and A. M. HARDING.